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Use of Rock-crevices in Winter by Big Brown Bats and Eastern Small-footed Bats in the Appalachian Ridge and Valley of Virginia

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ABSTRACT

Published accounts of North American bats overwintering in places other than caves and mines are rare. We used repeated visual searches for roosting bats to document use of sandstone rock-ledges in west-central Virginia by *Eptesicus fuscus* (Big Brown Bat) and *Myotis leibii* (Eastern Small-footed Bat) during two consecutive winters. Crevices used by both species tended to be smaller than nearby randomly selected crevices. It is unclear if bats hibernated exclusively in the rock-crevices or moved back and forth between them and other refugia such as caves or mines. Rock-crevices likely are more isolated and colder and drier than most caves and mines and conceivably could offer greater protection from White-nose Syndrome.

Key words: *Eptesicus fuscus*, hibernation, *Myotis leibii*, roosts, White-nose Syndrome.

INTRODUCTION

Overwintering habits of bats are an important part of their life history in temperate regions, a fact underscored by recent mortality from White-nose Syndrome (WNS), a disease caused by the fungus *Pseudogymnoascus destructans* (Gargas et al., 2009; Lorch et al., 2011). This disease has led to unprecedented reductions in populations of several bat species that hibernate in caves and mines in eastern North America (Turner et al., 2011). Species such as the Little Brown Bat (*Myotis lucifugus*), Northern Long-eared Bat (*Myotis septentrionalis*), and Tricolored Bat (*Perimyotis subflavus*), have experienced especially severe declines, whereas others such as the Big Brown Bat (*Eptesicus fuscus*) and Eastern Small-footed Bat (*Myotis leibii*) apparently have suffered substantial but less severe losses (Turner et al., 2011; Francl et al., 2012; Moosman et al., 2013). Lower mortality rates from WNS in *E. fuscus* and *M. leibii* may be because their hibernating habits make them less susceptible, from decreased fungal loads and growth rates (Langwig et al., 2012, 2016). Both *E. fuscus* and *M. leibii* tend to roost alone or cluster in relatively small groups, are found in colder and drier parts of hibernacula, and they often arrive at hibernacula later in the fall and leave earlier in the spring than other species of bats that have been affected by WNS (Kurta & Baker, 1990; Best & Jennings, 1997; Agosta, 2002).

Most knowledge of the overwintering habits of *E. fuscus* and *M. leibii*, and indeed other species of "cave-hibernating" bats in North America, is from caves and mines (and buildings in the case of *E. fuscus*), and mostly from eastern North America where karst habitat is abundant. However, a few studies hint that the overwintering habits of *E. fuscus* and *M. leibii* could be more diverse than has been commonly described in the literature. *Eptesicus fuscus* in the western portion of its range roosts in rock-crevices during cold weather in

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autumn and as hibernacula (Lausen & Barclay, 2006; Neubaum et al., 2006), and *M. leibii* in Virginia have been found in rock-crevices on talus slopes during periods of relatively extreme cold in spring and autumn (Moosman et al., 2015). The extent to which "cave-hibernating" bats overwinter on the landscape is still poorly understood, especially in eastern North America.

STUDY AREA AND METHODS

We observed *E. fuscus* and *M. leibii* roosting in crevices of southwest-facing sandstone ledges (Wilkes et al., 2007) during the winters of 2015-2016 and 2016-2017, in Goshen Pass (North 37°56', West 79°27'), a ravine formed by the Maury River as it passes southeast through the Appalachian Ridge and Valley Region, in Rockbridge County, Virginia. The rock-ledges are part of a popular sport-climbing area on the north side of the ravine and were accessible by the Goshen Pass Hiking Trail in the Goshen Wildlife Management Area and the Goshen Pass Natural Area Preserve. Elevations range from around 400 m at the river to 957 m at the summit of Jump Rock Mountain. We first observed a solitary *E. fuscus* on 5 December 2015, and revisited the crevice on 12 December to find it occupied by what may have been the same bat (Fig. 1). We returned and searched more crevices on 18 December 2015 and 3 January 2016 and found solitary *E. fuscus* in other crevices. After these four initial visits, we conducted 10 systematic surveys along the rock-ledges to document the extent to which bats used the site.

We surveyed for bats approximately every 1-3 weeks (average = 14 days between visits), including seven times between 9 February and 16 April 2016, and three times the following winter between 15 January and 18 February 2017. Surveys were conducted by 1-2 people who searched crevices along the rock-ledges for 1-2 person-hours per visit, on the same 3 km segment of trail where we initially observed bats. During surveys we visually inspected every crevice, regardless of size, between the ground and head height (about 2 m above ground) with 400-lumen flashlights for the presence of bats. Surveys covered only a small portion of potential roosting sites because the rock-ledges ranged from 1-m tall to higher than the forest canopy. The opposite side of Goshen Pass also had exposed rocky sites (predominantly northeast-facing) that we did not survey because access was more difficult and we were constrained by time. Rock-faces on both sides of Goshen Pass were predominantly under the tree canopy, but exposed to sunlight because trees lacked foliage. Capture and handling of bats was conducted under a scientific collecting permit (#056504) from the Virginia Department of Game and Inland Fisheries and approval from the Animal Subjects Committee at the Virginia Military Institute.

We marked roosts using aluminum numbered tags held in the crevice with heavy gauge metal wire and recorded latitude and longitude coordinates with a Magellan Triton 500 GPS unit (Santa Clara, California; ±5 m). We quantified microhabitat using methods similar to Neubaum et al. (2006), by determining length and width of the opening, and height from the ground to the bottom of the crevice (to the nearest 0.1 m) using a measuring tape. We defined width as the space between the two planar surfaces creating the crevice (i.e., top and bottom surfaces for horizontal crevices, or left and right surfaces for vertical crevices). The aspect of crevices was estimated using a magnetic compass. We obtained the same measurements (with the exception of aspect) from 12 randomly selected crevices. These were chosen by selecting a random direction along the ravine (west or east) and distance from the roost (≤ 15-m) using SPSS version 23 software (International Business Machines, Corp., Armonk, New York). We selected the rock-crevice nearest to each random point that was large enough for *E. fuscus* (the larger of the study species) to enter (opening at least 3.2 cm long x 1.0 cm wide; Greenhall, 1982). Dimensions of roosts and random crevices were compared using One-way ANOVA, with significant differences accepted at α of 0.05. All results are reported as mean ± SD.

RESULTS

During the 10 systematic surveys, we observed *E. fuscus* on five visits and *M. leibii* on three visits (2.19 ± 0.97 bats per person-hour of searching). Most bats were observed roosting solitarily, but we found pairs of bats on two occasions, including *M. leibii* on 1 March 2016 and *E. fuscus* on 11 March 2016. On 11 March, we also heard social calls of bats, which are typically produced by groups of roosting bats, emanating from too high above the ground for us to locate the source. We captured by hand and banded only three bats at the end of each winter to avoid influencing their behavior, thus it is unclear how many separate bats our observations represent. Captured bats included three male *E. fuscus* (1 scrotal and 1 non-scrotal on 16 April 2016; 1 scrotal on 4 February 2017), and one non-scrotal male *M. leibii* on 18 February 2017. Only the non-scrotal *E. fuscus* had blotches of white skin and physical scarring on its wings resembling that caused by WNS.

Average daily minimum and maximum temperatures on days we observed bats, obtained at a weather station 33 km away in the town of Hot Springs (Bath County), were 1.3 ± 7.4 °C and 9.9 ± 6.2 °C, respectively. The coldest day on which we observed bats was 4 February

Fig. 1. Examples of roosts used by *Eptesicus fuscus* (A) and *Myotis leibii* (B) during winter in Goshen Pass, Rockbridge County, Virginia. Rock-ledge A was 2-3 m high and was used on 5 and 12 December 2015; rock-ledge B was about 1 m high and was used on 18 February 2017.

Table 1. Comparison of rock-crevices used by *Eptesicus fuscus* and *Myotis leibii* during the winters of 2015-2017 and nearby random crevices, in Goshen Pass, Rockbridge County, Virginia. Data are reported as mean ± SD.

Type of Crevice	Observations of Bats (n) *	Crevices (n)	Length (cm)	Width (cm)	Height from Ground (cm)	Aspect (°)
Eptesicus fuscus	14	13	41.5±29.5	2.4±1.4	133±36	228±47
Myotis leibii	5	4	35.8±25.8	2.6±1.7	109±52	207±18
Random	-	12	40.5±23.5	6.1±7.2	101±71	203±49

* Total number of bats observed is not known because most bats were not banded.

2017 (min: -12.2 °C, max: 0 °C). Including all visits, we observed bats on 11 of 14 dates (79%). Roosts of both species of bats were in crevices of comparable dimensions; these tended to be barely wide enough for the bats to fit inside, and they were often narrower than randomly selected crevices (Fig. 1, Table 1). Roosts were statistically similar to random crevices with respect to width (P=0.072), aspect (P=0.501), length (P=0.625), and height from ground (P=0.729). Data from both winters combined indicate *E. fuscus* was present at Goshen Pass from (at least) early December until mid-April, and *M. leibii* from mid-February to mid-April, including days when the air temperature was below freezing.

DISCUSSION

These data are the first direct observations of *M. leibii* overwintering in rock-crevices and the only record to date of *E. fuscus* doing so in eastern North America. It is unclear whether the bats we observed hibernated exclusively in the rock-crevices in Goshen Pass, or if they made periodic movements between the crevices and other sites. Regardless, the frequency with which we encountered bats suggests the rock-ledges were an important overwintering resource. Langwig et al. (2016) showed that bats that hibernated solitarily or in small groups, and in colder microclimates had lower load and prevalence of the fungus that causes WNS. It is conceivable that hibernating in rock-crevices provides more isolation from other bats and colder microclimates than doing so in caves and mines, perhaps contributing to lower susceptibility to WNS.

More broadly, our observations cause us to ask: have bats changed their hibernating habits because of WNS, or has the behavior simply gone unnoticed because so much research has focused on caves and mines? We cannot answer this question, but note that: (1) *E. fuscus* and *M. leibii* routinely hibernate at particularly low temperatures compared to other species of bats in North America (Kurta & Baker, 1990; Best & Jennings, 1997); (2) rock-crevices are used as overwintering sites by *E. fuscus* (and perhaps the Western Small-footed Bat, *Myotis ciliolabrum*) in places with colder winters than much of eastern North America (Klug-Baerwald et al., 2017) and (3) other species of bats in eastern North America overwinter above ground, including Silver-haired Bats (*Lasionycteris noctivagans*) in tree cavities in Arkansas (Perry et al., 2010) and Eastern Red Bats (*Lasiurus borealis*) in conifers and leaf litter in Missouri (Mormann & Robbins, 2007). Thus, there seems little reason to think *E. fuscus* and *M. leibii* were not doing so prior to WNS. Additional study of the overwintering habits of these and other "cave-hibernating" species of bats is clearly warranted.

LITERATURE CITED

Agosta, S. J. 2002. Habitat use, diet and roost selection by the Big Brown Bat (*Eptesicus fuscus*) in North America: a case for conserving an abundant species. Mammalian Review 32: 179-198.

Best, T. L., & J. B. Jennings. 1997. *Myotis leibii*. Mammalian Species 547: 1-6.

Francl, K. E., W. M. Ford, D. W. Sparks, & V. Brack, Jr. 2012. Capture and reproductive trends in summer bat communities in West Virginia: Assessing the impact of white-nose syndrome. Journal of Fish and Wildlife Management 3: 33-42.

Gargas, A., M. T. Trest, M. Christensen, T. J. Volk, & D. S. Blehert. 2009. *Geomyces destructans* sp. nov. associated with bat white-nose syndrome. Mycotaxon 108: 147-154.

Greenhall, A. M. 1982. House bat management. United States Fish and Wildlife Service, Resource Publication 143: 1-33.

Klüg-Baerwald, B. J., C. L. Lausen, C. K. R. Willis, & R. M. Brigham. 2017. Home is where you hang your hat: winter roost selection by prairie-living big brown bats. Journal of Mammalogy 98: 752-760.

Kurta, A., & R. H. Baker. 1990. *Eptesicus fuscus*. Mammalian Species 356: 1-10.

Lausen, C. L., & R. M. R. Barclay. 2006. Winter bat activity in the Canadian prairies. Canadian Journal of Zoology 84: 1079-1086.

Langwig, K. E., W. F. Frick, J. T. Bried, A. C. Hicks, T. H. Kunz, & A. M. Kilpatrick. 2012. Sociality, density-dependence and microclimates determine the persistence of populations suffering from a novel fungal disease, white-nose syndrome. Ecology Letters 15: 1050-1057.

Langwig, K. E., W. F. Frick, J. R. Hoyt, K. L. Parise, K. P. Drees, T. H. Kunz, J. T. Foster, & A. M. Kilpatrick. 2016. Drivers of variation in species impacts for a multi-host fungal disease of bats. Philosophical Transactions of the Royal Society, B. 371: 20150456.

Lorch, J. M., C. U. Meteyer, M. J. Behr, J. G. Boyles, P. M. Cryan, A. C. Hicks, A. E. Ballmann, J. T. H. Coleman, D. N. Redell, D. M. Reeder, & D. S. Blehert. 2011. Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome. Nature 480: 376-379.

Moosman, P. R., Jr., J. P. Veilleux, G. W. Pelton, & H. H. Thomas. 2013. Changes in capture rates in a community of bats in New Hampshire during the progression of white-nose syndrome. Northeastern Naturalist 20: 552-558.

Moosman P. R., Jr., D. P. Warner, R. H. Hendren, & M. J. Hosler. 2015. Potential for monitoring eastern small-footed bats on talus slopes. Northeastern Naturalist 22: 1-13.

Mormann, B. M., & L. W. Robbins. 2007. Winter roosting ecology of eastern red bats (*Lasiurus borealis*) in southwest Missouri. Journal of Wildlife Management 71: 213-217.

Neubaum D. J., T. J. O'Shea, & K. R. Wilson. 2006. Autumn migration and selection of rock crevices as hibernacula by big brown bats in Colorado. Journal of Mammalogy 87: 470-479.

Perry, R. W., D. A. Saugey, & B. G. Crump. 2010. Winter roosting ecology of silver-haired bats in an Arkansas forest. Southeastern Naturalist 9: 563-572.

Turner, G. C., D. A. M. Reeder, & J. T. H. Coleman. 2011. A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look into the future. Bat Research News 52: 13-27.

Wilkes, G. P., E. W. Spencer, N. H. Evans, & E. V. M. Campbell. 2007. Geology of Rockbridge County, Virginia. Virginia Division of Mineral Resources, Publication 170. 33 pp.